Nima Amir Dastmalchi (505320372)

CS 118

Homework #1

**Problem 1**

Part A: The infinite sum of the absolute value of the coefficients is proportional to the area under the curve of one period of the square wave function. Since the square wave is bounded, the infinite sum must converge, so the coefficients must decrease as “n” increases.

Also, the integral of sin(nx) ~ (1/n) sin(nx). Because harmonics have increasing frequency, as we add more terms (n increases), the coefficients also increase.

Part B1:

Chart, line chart

Description automatically generated

Link to Desmos: <https://www.desmos.com/calculator/xkfwju7rxs>

Part B2:

TODO: SSs

Note that for all 5 approximations.

For approximation 1 (n = 1), , so the bandwidth is .

For approximation 2 (n = 2), , so the bandwidth is .

For approximation 3 (n = 3), , so the bandwidth is .

For approximation 4 (n = 4), , so the bandwidth is .

For approximation 5 (n = 5), , so the bandwidth is .

Part B3:

TODO: use pi/4 factor

For n = 1, the lowest value between 0.1s and 0.4s is 0.588V, which results in 41.2% error.

For n = 2, the lowest value between 0.1s and 0.4s is 0.667V, which results in 33.3% error.

For n = 3, the lowest value between 0.1s and 0.4s is 0.693V, which results in 30.7% error.

For n = 4, the lowest value between 0.1s and 0.4s is 0.700V, which results in 30.0% error.

For n = 5, the lowest value between 0.1s and 0.4s is 0.704V, which results in 29.6% error.

We see that percent error decreases with better approximations.

Part B4:

For n = 1, the wave reaches 0.9V at t = 0.1782s.

For n = 2, the wave reaches 0.9V at t = 0.0985s.

For n = 3, the wave reaches 0.9V at t = 0.0674s.

For n = 4, the wave reaches 0.9V at t = 0.051s.

For n = 5, the wave reaches 0.9V at t = 0.041s.

**Problem 2**

Part 2.1: Slow rate of every 2 usec

Chart, line chart

Description automatically generated

The receiver outputs 101.

Part 2.2: Fast rate of every 1usec.

Chart, line chart

Description automatically generated

The receiver outputs 101.

Part 2.3: Super-sonic rate of every 0.5us.

Chart, line chart

Description automatically generated

There is inter-symbol interference at the sample instance at 1.5us.

The receiver outputs 111.

**Problem 3**

Part 3.1 and 3.3:

Part 3.2: The 10th sampling is at t = 9.5us. The 10th bit will start at t = 9.72us because of the slower sender clock. Therefore, the sample is off by 0.22us.

Part 3.4:

TODO: 1 to 2 is a transition

If there is a sharp noise spike of 1V at time 0.3 usec, then sampling times will not be affected. This is because the signal at t=0.3usec is already “high”, so a signal spike will not result in a transition detection. This means that the given pseudocode will run as it would without the spike.

Part 3.5:

If there is a sharp noise spike of -1V at time 2.7 usec, then a false transition will be detected at actual time A = 2.7 usec while waiting to reach time t = 3.5 usec. Thus, the detector will think that there was a transition at t = 2.7 usec while it is expecting that a transition should have happened at P = 3 usec. Thus, the lag value will be -0.3 usec and all future sampling instances will be shifted to the left by 0.3 usec.